

# Excretory System

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Least toxic removed with minimum water.

Most toxic requires large amount of water

Animals accumulate

Ammonia

Urea

Uric Acid

$\text{Na}^+$

$\text{CO}_2$  & water

Maj or form of nitrog. waste by animals.

phosphate & sulphate

either by metabolic activity / excretion

These substance to be removed partially / wholly

Terrestrial adapt necessitated less toxic nitrog waste for water consv.

Ammonotelic

Ureotelic

Uricotelic

- Bony fishes
- Aquatic amphibians
- Aquatic insects

- Mammals
- Marine fishes
- Terrestrial amphibians

- Reptiles
- Birds
- Land snails
- insects

Ammonia is

Readily soluble  
Excreted by diffusion through body surface or gill surface (fish) as  $\text{NH}_4^+$ .

\* Kidneys don't play any major role.

by metabolism

Ammonia  $\xrightarrow{\text{In Liver}}$  urea  
↓  
Released in blood & filtered out

Some amt of urea

Retained

To maintain desired osmolarity.

• pellet / paste form

↓  
minimum loss of water.

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AIR 1747

NCERT THREAD NOTES

JGA → special sensitive region → cellular modification at the location of contact of

DCT

afferent arteriole



Invertebrate → simple tubular forms  
Vertebrates → Complex tubular organs.  
(Kidneys)

Protonephridia → Platyhelminths (flatworm → planaria)  
/ flame cell  
Rotifers  
Some annelids

↓  
mainly osmoreg.  
↓  
ionic reg.      fluid volume reg.

[Cephalochordates - Amphibians]

↓  
A chordate animal

Nephridia → Earthworm  
(tubular)      Other annelids

↓  
Removes nitrog. waste      fluid & ionic balance.

Malpighian tubules → Most insects (cockroaches)

↓  
excretion      osmoregulation

Antennae / Green gland → Crustaceans (Prawns)

↓  
excretory funct.

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\* Nature of nitrog. wastes formed & their excretion vary among animals. mainly depending on the habitat (availability of water)

# HUMAN EXCRETORY SYSTEM.

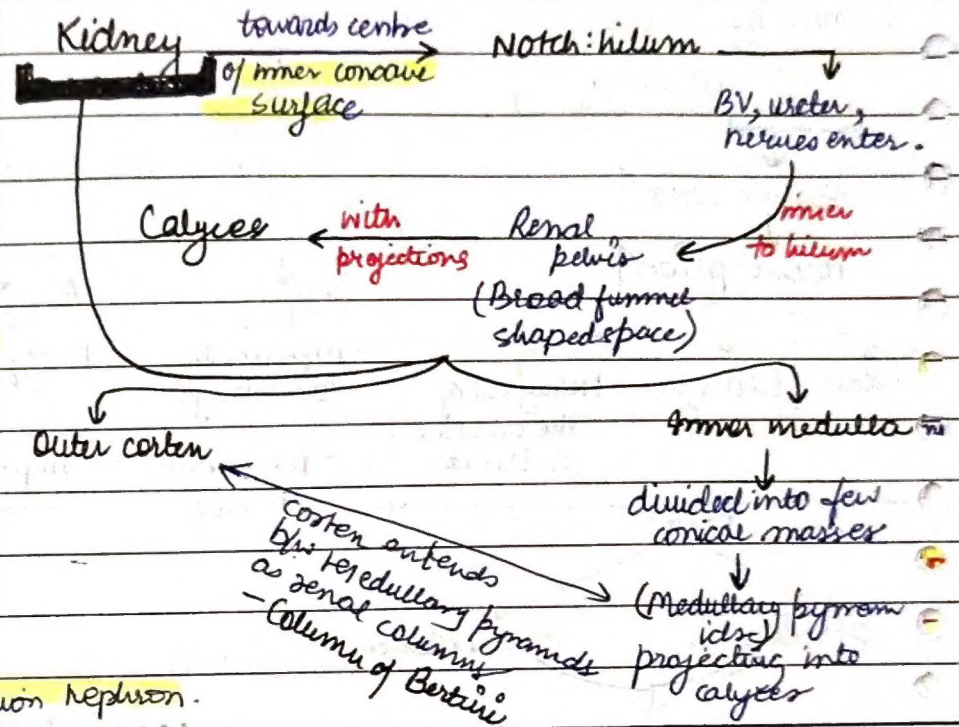
① A pair of kidney

② A pair of ureter

③ Urinary bladder

④ Urethra

- Reddish brown
- Bean shaped
- T<sub>12</sub> - L<sub>3</sub>
- Close to dorsal inner wall of abdominal cavity
- 10-12 cm - L
- 5-7 cm - W
- 2-3 cm - thick
- 120-170 gm.



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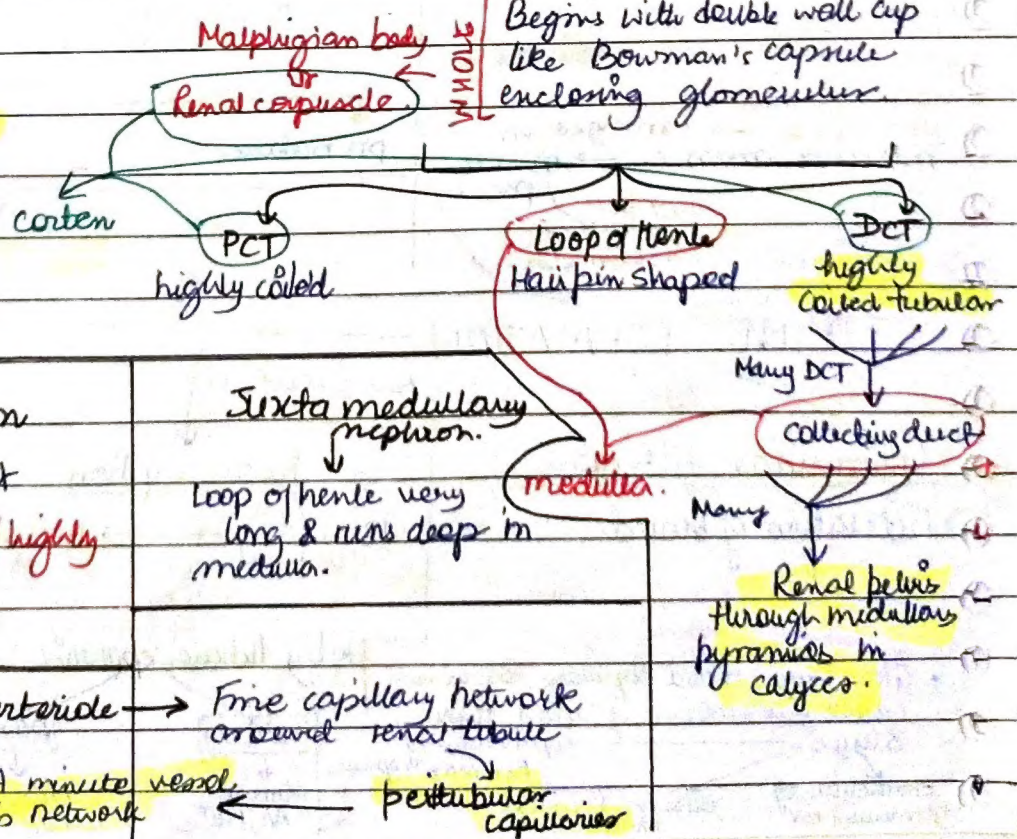
NEPHRON (tubular)

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Glomerulus

Renal tubule.

tuft of capillaries formed by afferent arteriole - a fine BRANCH of Renal artery & blood carried away by efferent arteriole



Cortical nephron

Loop of Henle short

Vasa recta Absent / highly reduced

\* More common

Juxta medullary nephron.

Loop of henle very long & runs deep in medulla.

\* Efferent arteriole

Fine capillary network around renal tubule

peritubular capillaries

Parallel to henle loop

A minute vessel of this network

NCERT THREAD NOTES



\* Amt of filtrate formed by kidney / min

GFR  $\rightarrow$  125 mL/min i.e. 180 L/day

\* Reabsorption of water also occurs in initial segments of nephron.

## FUNCTION OF THE TUBULES

### PCT

(lined by simple cuboidal brush border epithelium)

Surface area  $\uparrow$

reabsorption  $\uparrow$

Water Electrolytes Nearly all of the essential nutrients  
70-80% of

### PCT

pH balance

ionic balance

① By Selective secretion of  $H^+$ ,  $NH_3$ ,  $K^+$

② absorption of  $HCO_3^-$

### Henle's Loop

\* Reabsorption min. in ascending limb

\* Maintaining high osmolarity of medullary interstitial fluid.

Descend. limb

$\rightarrow$  impermeable to electrolyte

Ascending limb

$\rightarrow$  permeable to electrolyte

$\rightarrow$  permeable to water

$\rightarrow$  impermeable to water

### DCT

\* Conditional reabsorption of  $Na^+$  & water ex. takes place here.

reabsorp.

$HCO_3^-$

selective secretion

$H^+$ ,  $K^+$

$NH_3$

maintains

pH bal.

sodium - potassium balance in blood

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NCERT THREAD NOTES

### Collecting Duct

$\rightarrow$  cortex  $\rightarrow$  medulla.

\* Large amt. of water reabsorbed here.

\* This passage allows small amt. of urea into the medullary interstitium to keep up the osmolarity.

maintains

pH balance

selective secret.  $H^+$ ,  $K^+$ ,  $NH_3$

ionic balance

Podocyte - epithelial cell of Bowman's capsule.  $\rightarrow$  arranged in intricate manner  $\rightarrow$  minute spaces. Almost all constituents of plasma except protein pass to lumen of Bowman's capsule. slit pore & filtration slits.

## URINE FORMATION

### Glomerular filtration

• Filtration of blood

1200 mL by kidney/min (1/5th of cardiac output)

• Glomerular blood capillary pressure cause filtration of blood through 3 layers.

endothelium of glomerular BV

Basement memb. b/w the two.

### Reabsorption

180 L/day (filtrate)

$\rightarrow$  1.5 L/day (urine)

99% reabsorbed by renal tubules.

\* by tubular epithelial cells

actively

glucose AA,  $Na^+$

passive

Nitrogenous waste

### Tubular secretion

•  $H^+$ ,  $K^+$ ,  $NH_3$  into filtrate.

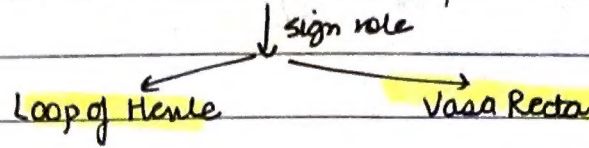
pH (acid-base) balance

ionic balance



# MECHANISM OF CONCENT. OF THE FILTRATE

→ Mammals ability → Concentrated urine production



→ Flow of blood through two limbs

```

    graph LR
      A[Flow of blood through two limbs] --> B[loop of henle]
      A --> C[vasa recta]
      B --> D[Counter current mechanism]
      C --> D
  
```

→ Proximity b/w Henle loop & Vasa recta

Counter current in them

Maintaining an increasing osmolarity towards inner medullary interstitium

In cortex

300 mOsmol<sup>-1</sup>  
↓  
1200

In inner medulla

Caused by

Urea

Nace

- It enters the thin segment of the ascending limb of loop of henle

②

- transported back to interstitium by collecting tubule

- Returned to the interstitium by the ascending limb of Henle loop vasa recta

②

- Nace is transported by ascending limb of henle loop which is exchanged by descending limb of vasa recta

→ Presence of such interstitial gradient helps in an easy passage of water from collecting tubule → concentr. urine

4 times concentrated than the initial filtrate



# REGUL. OF KIDNEY FUNCTION.

efficiently monitored & regulated by hormonal feedback.

involving hypothalamus

JGA

Heart  
(to certain extent)

Osmoreceptors

activated by

- ① changes in blood volume,
- ② blood fluid volume
- ③ ionic conc.

excessive loss of fluid

receptors activated

stimulate

Hypothalamus

ADH/Vasopressin

Facilitates absorption of water from latter parts.

Prevents diuresis

Constrictory effects on BV

increase in BP

\* GFR ↑  
↳ CFR ↑

increase in blood fluid volume

\* GBF

↳ Glomerular Blood flow.

JGA

Complex regulatory Role

Fall in GFR

JG cell activate

release renin

Angioten  
Sinhogen  
(Liver)

Angioten  
sin - I

By  
Lungs  
A  
C  
E

Angiotensin - II

Power  
vasoconstrictor

Activate adr  
enal center

Aldosterone

Reabsorption of  
water &  
Na<sup>+</sup>  
from DCT.

↑ BP

←

Glomerular  
Blood pressure

↑ CFR

←

RAAS → Renin Angiotensin Aldosterone system

Blood flow to  
atria of heart

↑

ANF  
release

cause

Vasodilation

BP ↓

Check on RAAS  
mechanism



- \* **PCT** - major site reabsorption & selective secretion.
- HL** - primarily maintain osmotic gradient within the kidney interstitium.
- DCT & collecting duct** - extensive reabsorption of water & certain electrolytes, which help in osmoregulation.

## DISORDERS OF THE EXCRETORY SYSTEM.

Malfunction of kidney

Accumul. of urea in blood

Uremia

harmful, leads to kidney failure

Can be removed by

Hemodialysis

Blood drained from a convenient artery

Dialysing Unit / Artificial kidney  
(after adding anticoagulant - heparin)

"Boon" for uremic patients.

Convenient Vein

after adding anti-heparin  
Blood cleaned.

As nitrog. wastes are absent in dialysing fluid, these sub. freely move out

contains coiled cellophane tube, surrounded by dialysing fluid.

have some comp. as plasma except nitrog. waste.

Porous cellophane memb. allows the passage of mol. based on conc. gradient.

(Kidney failure)

\* Ultimate method in correct. of acute Renal failure → **Kidney Transplantation**

Modern clinical proced. have ↑ the success rate of such complic. technique.

Transplanted

A functioning kidney from donor

preferably a close relative

To minimise its chance for rejection by immune syst. of host

RENAL CANALICULI

formed within kidney

Stone

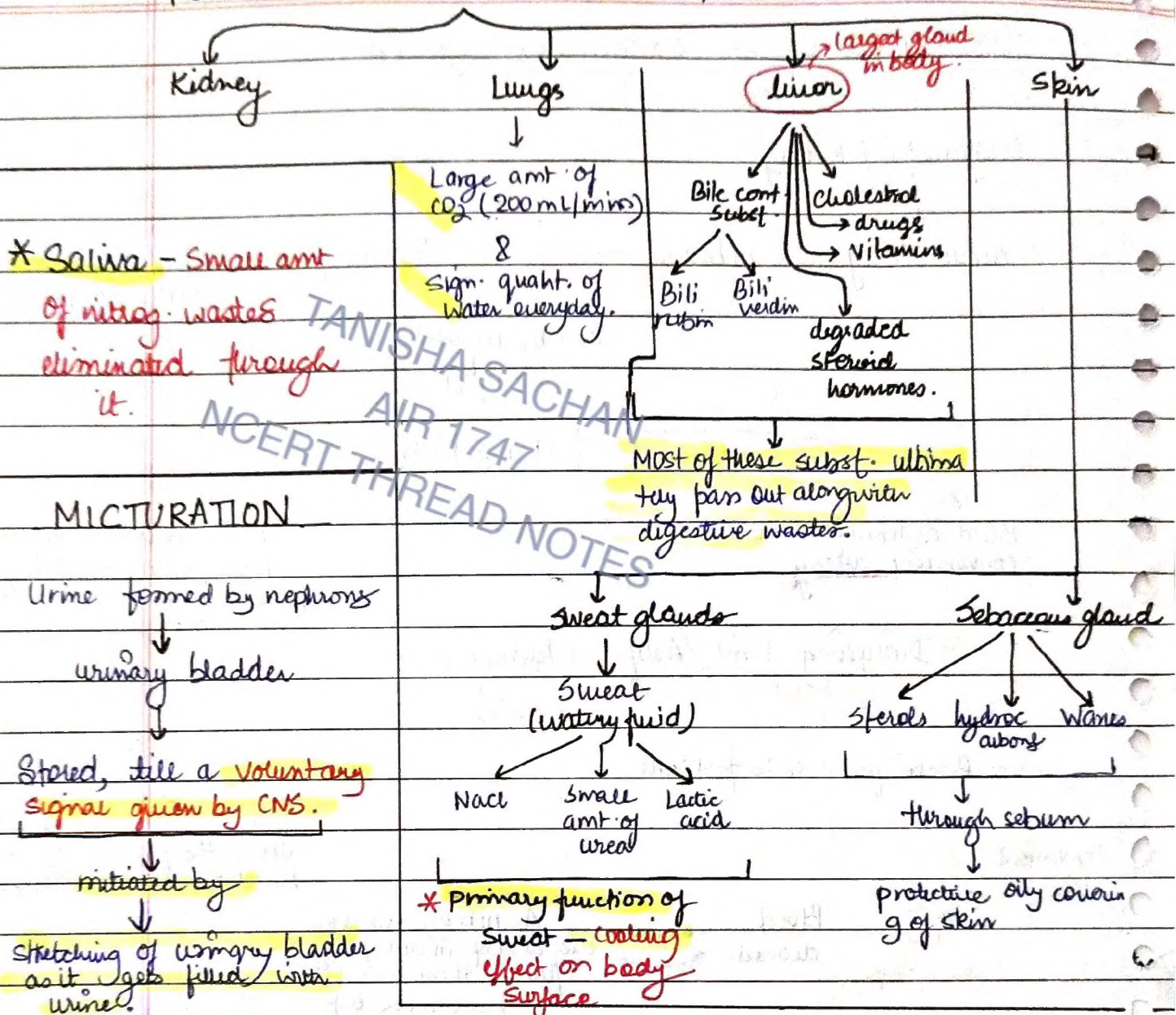
Irreducible mass of crystallised salts (concreta)

GLOMERULONEPHRITIS → Inflammation of glomeruli of kidney.



- \* Micturition is carried out by reflex - True
- \* Protein free fluid is filtered from blood plasma into Bowman's capsule - True
- \* Henle loop plays imp role in concentrating urine - True
- \* Glucose is actively reabsorbed in PCT - True

## ROLE OF OTHER ORGANS IN EXCRETION



On an average,

Urine: 1-1.5 L/day

- light yellow
- watery fluid
- slightly acidic (pH-6)
- charact. odour
- 25-30 gm urea/day

Metabolic disorders may be identified by analysis of urine

- Glycosuria: presence of glucose
- Ketonuria: presence of ketone bodies

indicative of diabetes mellitus